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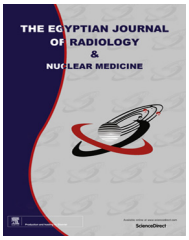

ORIGINAL ARTICLE

Gray scale and Doppler ultrasound in placenta accreta: Optimization of ultrasound signs

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KEYWORDS

US;
Doppler;
Placenta accreta;
Placental lacunae

Abstract *Aim of work:* To optimize ultrasound and Doppler signs in placenta accreta, and to clarify sensitivity and specificity.
Patients & methods: This study included 50 pregnant women. The examinations were done in private center from January 2013 to November 2013. Patients have anterior low lying placenta or anterior placenta previa with history of previous CS. US was done using curvilinear or endovaginal transducer at frequency 3–5 MHz and 3–9 MHz.
Results: This study included 50 pregnants with mean age of 29.92 y. Placental lacunae, loss of retroplacental space, retroplacental myometrial thickness, echogenic bladder wall (hyperechoic uterine serosato–bladder interface) and Doppler criteria were evaluated. Of 18 cases having placenta accreta, 16 (88.9%) had placental lacunae with Doppler abnormality. *P* values for the above mentioned US signs were <0.001(HS), 0.006(S), <0.001(HS), 0.019(HS). Placental lacunae were found in 16 of 18 women with placenta accreta with sensitivity of 89%, specificity of 81%, 73% positive predictive value and 93% negative predictive value. Placental lacunae were found in 6 women (18.8%) with no placenta accreta.
Conclusion: Ultrasound and Doppler examinations of placenta have signs highly suggestive of placenta accreta due to high sensitivity and specificity with placental lacunae of turbulent flow and retro-placental myometrial thickness $\leqslant 1$ mm are of the highest specificity.

1. Introduction

The placenta is often overlooked in the routine evaluation of a normal gestation, receiving attention only when an abnormality is detected. Although uncommon, abnormalities of the placenta are important to recognize owing to the potential for maternal and fetal morbidity and mortality (1).

Placenta accreta occurs when the chorionic villi invade the myometrium abnormally. It is divided into three grades based on histopathology: placenta accreta where the chorionic villi are in contact with the myometrium, placenta increta where the chorionic villi invade the myometrium, and

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placenta percreta where the chorionic villi penetrate the uterine serosa (2).

Risk factors for placental attachment disorders (PAD) have been clearly documented—placenta previa, previous Cesarean section and age are the most common. More infrequent risk factors are Asherman syndrome and endometrial ablation. An increase has also been seen in in vitro fertilization pregnancies (3). The risk of placenta accreta is 24% in women with placenta previa and one prior Cesarean delivery and 67% in women with placenta previa and three or more prior Cesarean deliveries (4).

The exact pathogenesis of placenta accreta is unknown. A proposed hypothesis includes a maldevelopment of decidua, excessive trophoblastic invasion, or a combination of both. Defective decidualization, abnormal maternal vascular remodeling, excessive trophoblastic invasion, or combinations are considered to be the consequences of previous instrumentation (5).

Clinically, hypertrophied disorganized uteroplacental vascularity in patients with placenta accreta creates a risk of massive intrapartum hemorrhage. Other maternal complications of placenta accreta include disseminated intravascular coagulation, damage to the ureters or bladder, sepsis, and deep venous thrombosis. Patients with placenta accreta usually deliver by Cesarean section at 34–35 weeks after fetal lung maturity has been documented. Cesarean delivery is carefully planned with arrangements for possible multiple intraoperative transfusions and multispecialty consultations including interventional radiologists and experienced surgeons (6).

Second and third trimester gray-scale sonographic characteristics include loss of continuity of the uterine wall, multiple vascular lacunae (irregular vascular spaces) within placenta, giving "Swiss cheese" appearance adjacent to the placental implantation site, lack of a hypoechoic border (myometrial zone) between the placenta and the myometrium, bulging of the placental/myometrial site into the bladder, and increased vasculature evident on color Doppler sonography (7).

2. Patients and methods

2.1. Patients

This study included 50 pregnant women. The examination was done in private center from January 2013 to November 2013. The range of age was from 20 to 37 year (with mean age = 29.92 SD ± 3.99). All patients have anterior low lying placenta or anterior placenta previa with history of previous Cesarean section.

2.2. Methods

Ultrasound was done by ultrasound machines using the curvilinear transducer (at frequency 3–5 MHz) or endovaginal transducer (at frequency 3–9 MHz). The lower uterine segment is evaluated using the highest-frequency transducer that can produce an adequate image, which is often a 5-MHz transducer. Transabdominal imaging is performed with the patient's bladder full. Transvaginal US is always performed when the placenta is low lying or placenta previa is present. The placenta was assessed for the following:

1. Placental lacunae: The lacunae are assessed for the number, the site whether near or away from the myometrium, the shape (irregular, linear or round), the borders (echogenic or non-echogenic i.e. distinct or indistinct) and Doppler study (turbulent or non-turbulent flow).
2. Retroplacental space, whether present or absent.
3. Retroplacental myometrial thickness: is measured in millimeter.
4. The bladder wall (hyperechoic uterine serosa-to-bladder interface): is assessed for smooth echogenic appearance or interrupted and focal bulge anteriorly.
5. Color Doppler study of the placenta:

– The placental lacunae (turbulent, tornado sign or non-turbulent).
– Increased peri-uterine vascularity between uterus and urinary bladder.

2.3. Statistical analysis

Results were collected, tabulated, and statistically analyzed by IBM personal computer and statistical package SPSS version 20. Two types of statistics were done:

1. Descriptive: e.g. percentage (%), mean.
2. Analytical:-

(A) Sensitivity or true positive rate (TPR) = True +ve/(True +ve + False −ve).
(B) Specificity (SPC) or True Negative Rate = True −ve/(True −ve + False +ve) = 1 − False +ve rate.
(C) Positive predictive value (PPV): True +ve/(True +ve + False +ve).
(D) Negative predictive value (NPV): True −ve/(True −ve + False −ve).
(E) *P* value.

- Significant difference if $P < 0.05$.
- Non-significant difference if $P > 0.05$.
- Highly significant difference if $P < 0.001$.

3. Results

This study included 50 pregnant women with a mean age of 29.92 year and age range of 20–37 year. In 18 of the enrolled 50 pregnant woman, placenta accreta was diagnosed by surgical criteria on doing Cesarean section (one case was placenta percreta on laparotomy).

The ultrasound signs namely placental lacunae, loss of retroplacental space, retroplacental myometrial thickness, the echogenic bladder wall (hyperechoic uterine serosa-to-bladder interface) and Doppler criteria were evaluated. Of the 18 cases having placenta accreta, 16 (88.9%) had placental lacunae, 16 (88.9%) had absent retroplacental space, 6 (33.3%) had lost the hyperechoic uterine serosa-to-bladder interface (Fig. 4), and 12 (66.7%) had myometrial thickness less than 1 mm with Doppler abnormality (Figs. 5 and 6). *P* value for the above mentioned US signs was <0.001(HS), 0.006(S), <0.001(HS), and 0.019(HS).

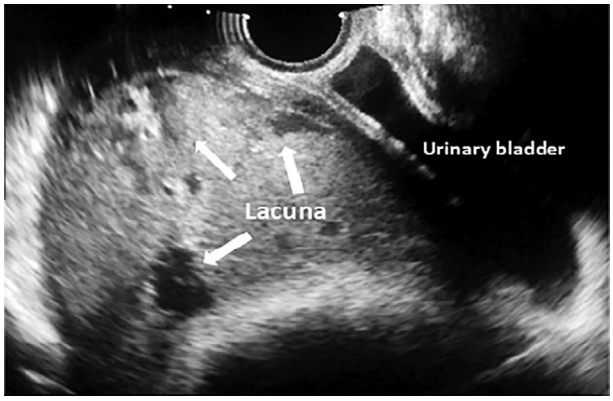

Fig. 1 Transvaginal gray scale ultrasonography showing multiple intra-placental superficial and deep irregular shaped anechoic areas with non-echogenic walls denoting intra-placental lacunae (arrows).

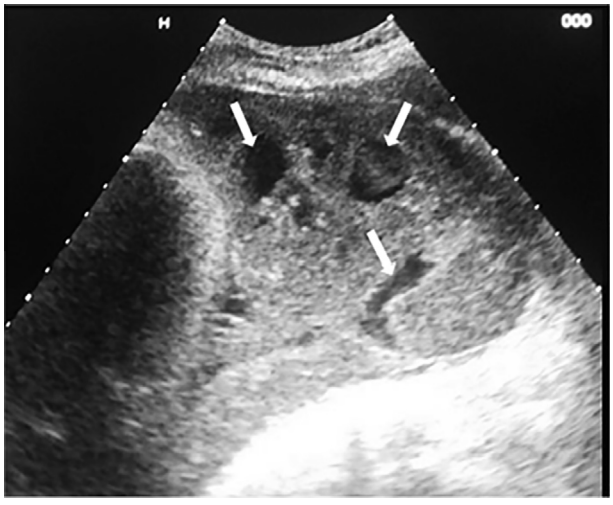

Fig. 2 Gray scale sagittal view: Placenta previa with multiple intra-placental anechoic areas of oval, round and linear shape. Two are superficial with non-echogenic walls and one is deep with echogenic walls denoting intra-placental lacunae (Arrows).

Placental lacunae (Figs. 1 and 2) were found in 16 of 18 women with placenta accreta with sensitivity of 89%, specificity of 81%, 73% positive predictive value and 93% negative predictive value. Placental lacunae were found in 6 women (18.8%) with no placenta accreta. The lacunar border was irregular in 14 of 18 women with placenta accreta (87.5%) with sensitivity of 88%, specificity of 100%, PPV of 100% and NPV of 75% and was regular in 2 of 18 women with placenta accreta (12.5%). Lacunar border was regular in all the 6 women showing lacunae (100%) from the 32 women with no placenta accreta. Lacunae were oval shaped in 6 (37.5%) of women with placenta accreta and linear shaped in 10 (62.5%) of women with placenta accreta with sensitivity, specificity, PPV and NPV were 38%, 33%, 60% and 17% respectively and *P* value = 0.348(NS). Lacunae were deep in placenta in 6 (37.5%) of women with placenta accreta and superficial in 10 (62.5%) of women with placenta accreta with sensitivity, specificity, PPV and NPV were 38%, 67%, 75% and 29% respectively and *P* value = 1.0 (NS). Lacunar wall was echogenic in 4 (25%) of women with placenta accreta and non-echogenic in 12 (75%) of women with placenta accreta, with sensitivity, specificity, PPV and NPV were 75%, 100%, 100% and 60% respectively and *P* value = 0.003(S). Lacunar flow (Fig. 3) was turbulent in 14 (87.5%) of women with placenta accreta and no flow in 2 (12.5%) of women with placenta accreta, with sensitivity, specificity, PPV and NPV were 88%, 100%, 100% and 75% respectively and *P* value <0.001(HS). Increased periuterine vascularity was found in 14 cases of 18 cases with placental accretion (77.8%) and in 14 cases of 32 cases with no accretion (43.8%), with sensitivity of 78%, specificity of 56%, Positive predictive value of 50% and Negative predictive value of 82%.

The absence of the retroplacental clear space was noted in 16 of 18 women with placenta accreta but also in 16/32 women without accreta, yielding a sensitivity of 89%, a specificity of 50% and positive predictive value of 50%.

Retro-placental myometrial thickness equals to or less than 1 mm sensitivity = 67%, specificity = 100% and PPV = 100%.

The hyperechoic uterine serosa-to-bladder interface sign shows sensitivity = 33% and specificity = 94%, PPV = 75%. We had only two cases of placenta percreta and loss of the hyperechoic uterine serosa-to-bladder interface sign was seen in the two cases.

4. Discussion

In its severest manifestations when the abnormally attached placenta is forcefully detached from the uterine wall, there

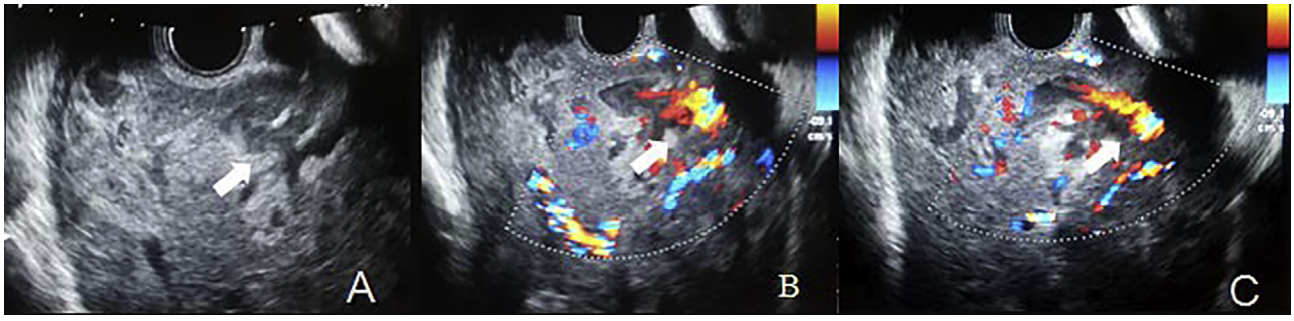

Fig. 3 (A) Gray scale transvaginal: Arrow shows placental lacunae. (B) Color Doppler of the same region shows turbulent flow of venous, arterial or mixed blood. (C) Color Doppler of the same region shows Tornado sign (arrow).

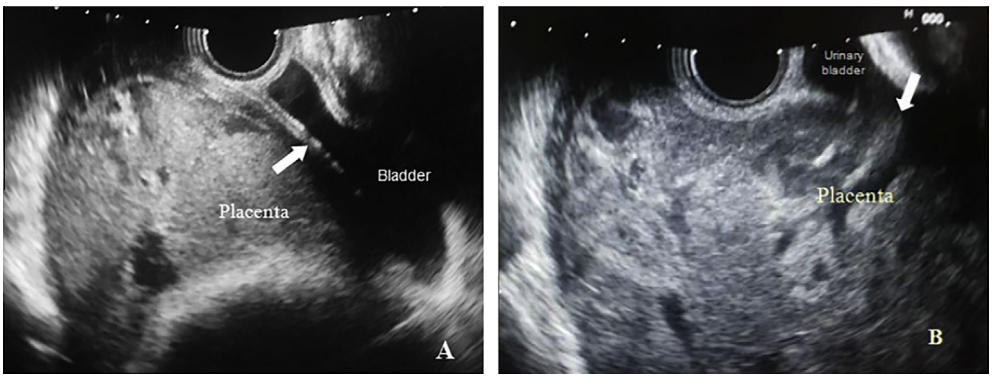

Fig. 4 (A) Gray scale transvaginal view: Arrow shows normal echogenic bladder-uterine serosal line (arrow). (B) Gray scale endocavitary view in another patient: Arrow shows loss of echogenic bladder-uterine serosal line with placental tissue extending into bladder cavity.

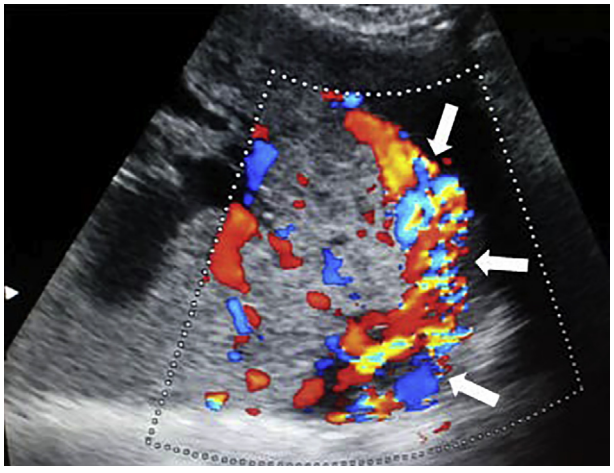

Fig. 5 Color Doppler Examination, sagittal view: Increased peri-uterine vascularity of mixed arterial and venous color signal (arrows).

can be massive bleeding, medical complications such as renal and respiratory failure, and potentially death. In antenatally suspected placenta accreta, the best outcomes occur when the infant is delivered and the uterus is removed intact without separating the placenta. Consequently, it is desirable to identify placenta accreta before birth so plans can be made for a controlled delivery, available blood products, and back up surgical help (8). It has become the leading cause of emergency hysterectomy (9).

The numerous complications and even deaths we heard from our obstetrician colleagues hit our mind to try to optimize the ultrasound signs to antenatally diagnose placenta accreta.

Several authors have reviewed the diagnostic accuracy of sonographic criteria for placenta accreta. The risk of performing an unnecessary hysterectomy (false positive) or the risk of secondary bleeding following attempted placental removal (false negative) should always be considered. An evaluation based solely on sensitivity and specificity is not sufficient to legitimize the use of diagnostic criteria; assessing PPV and NPV is mandatory to planning appropriate management and information of patients (10).

Placental lacunae (Figs. 1 and 2) have a sensitivity of 89%, specificity of 81%, positive predictive value of 73% and negative predictive value of 93%. These results were in agreement with a study by Wong et al. (7) in sensitivity but in disagreement with specificity and positive predictive value of 39% and 17%, respectively. And it was in agreement with study by Cali et al. (10) in sensitivity of 73%, specificity of 86%,

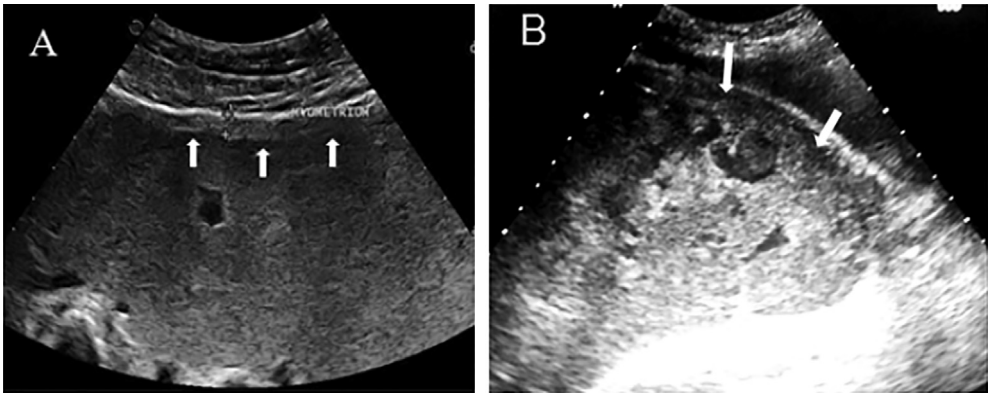

Fig. 6 (A) Gray scale ultrasound sagittal view: Arrow shows normal myometrial thickness. (B) Gray scale ultrasound sagittal view in another patient: Arrow shows non-visualized myometrium.

positive predictive value of 60% and negative predictive value of 90%.

We found that location of lacunae whether deep or superficial is not specific. There was no statistically significant difference (P value = 1.0), and this was in agreement with study by Twickler et al. (11).

In this study the number (grade) of lacunae was an indicator of likelihood of placenta accreta; this is in agreement with study by Finberg and Williams (12).

We found that linear lacunae are more likely with placenta accreta, and this was in agreement with study by Comstock et al. (13).

While the irregular lacunar border is more likely with placenta accreta (14 of 16 case) (PPV = 100%), this was in agreement with study by Comstock (14).

We found that lacunae with non-echogenic border are more likely with placenta accreta (PPV = 100%), and this was in agreement with study by Comstock (14), while lacunae with turbulent flow (Tornado-shaped flow of venous, arterial or mixed blood) are more likely with placenta accreta (PPV = 100%) (Fig. 3). This was in agreement with study by Comstock (14).

In our study we found that the absence of retroplacental space had PPV = 50% indicating low diagnostic value, and this was in agreement with study by Comstock (14) and study by Cali et al. (10) where PPV = 57%.

The absence of the retroplacental clear space was noted in 16 of 18 women with placenta accreta but also in 16/32 women without accreta, yielding a sensitivity of 89%, a specificity of 50% and positive predictive value of 50%. This high false positive rate has been noted in studies by Comstock et al. (13) and Wong et al. (7).

We found that Retroplacental myometrial thickness (Fig. 6) equals to or less than 1 mm is highly predictive of placenta accreta with a statistically significant association with placenta accreta, sensitivity = 67% and specificity = 100%, PPV = 100%, and this was in agreement with study by Wong et al. (7).

In this study, the hyperechoic uterine serosa-to-bladder interface sign shows sensitivity = 33% and specificity = 94%, PPV = 75%, and this was in agreement with study by Cali et al. (10) regarding the specificity (99%) and PPV = 90%, denoting the importance of this sign in diagnosis of placental accretion.

In this study, increased periuterine vascularity (between uterus and bladder) was found in 14 cases of 18 cases with placental accretion (77.8%) and in 14 cases of 32 cases with no accretion (43.8%), with sensitivity of 78%, specificity of 56%, Positive predictive value of 50% and Negative predictive value of 82%, and this disagreed with study by Cali et al. (10) who found sensitivity of 90%, specificity of 100%, Positive predictive value of 100% and Negative predictive value of 97%, and we can explain this due to the presence of granulation tissue at this site of surgical manipulation from previous Cesarean section.

5. Conclusion

Ultrasound and Doppler examinations of placenta have signs highly suggestive of Placenta accreta due to high sensitivity and specificity with placental lacunae of turbulent flow and retro-placental myometrial thickness $\leqslant$1 mm are of the highest specificity.

We recommend performing ultrasound and Doppler study on suspicion of placental accretion taking placental lacunae with turbulent flow and decreased myometrial thickness as the most important signs.

Conflict of interest

The authors declare that there are no conflict of interests.

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